Space Weather Technical Forecast

Issued on Saturday, 03 February 2024 at 00:35 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of R1. Peak Chance of G1 Sunday 04 February.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity, as measured by GOES16, has been Moderate, with AR3571 producing an impulsive M1.1 flare at 02/0301UTC.

There are now seven numbered sunspot regions on the disc. The main changes in the period were a fading trend in all spots in AR3567 in the northeast, some forward migration of intermediate spots in AR3565, and a proliferating and spreading tendency in AR3575. Although one of the less threatening regions on paper, AR3571 has produced a number of flares in the past 24 hours, with a number of these apparently magnetically connected to the trailing portion of coronal hole 96 nearer the solar meridian.

Two such flares were also associated with Type II radio emissions - the first at 02/0306UTC with an estimated speed of 1444km/s, and the second at 02/1107UTC with a speed of 874kms, with ejecta then clear on coronagraphs being mainly directed behind and below the Sun-Earth line, but with analyses ongoing. AR3571 is only borderline even a magnetically bipolar group, however numerous coronal dimmings were in evidence in AIA211, and confidence in the detail of Coronal Mass Ejections (CMEs) from this part of the disc is now low, with AIA211 evidence perhaps suggesting events higher in the corona may be possible (no significant H-Alpha activity was noted).

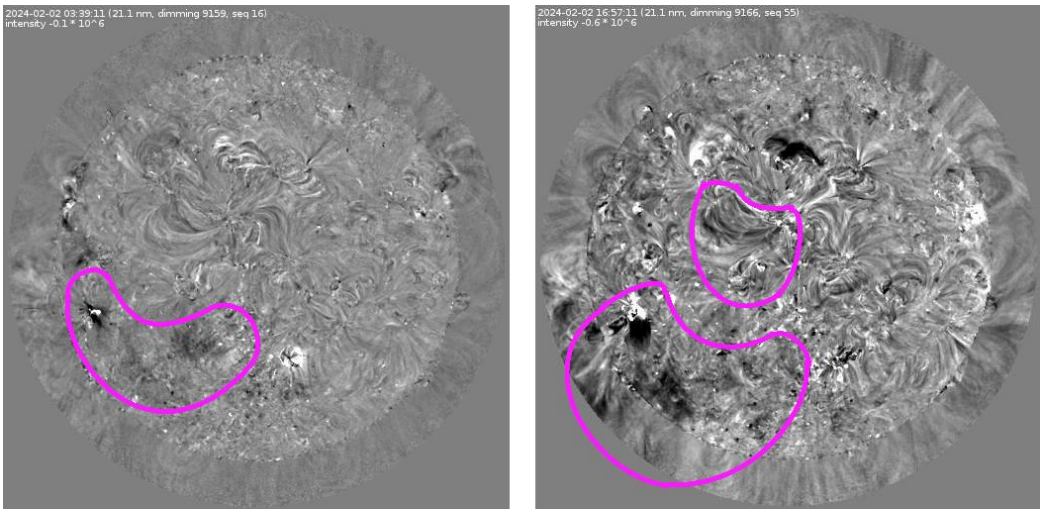

Figure 0: SIDC ROB time-integrated AIA211 dimmings from AR3571. Both of these events resulted in CMEs and Type II radio bursts, although this is far from an exhaustive list of events from this region in the period. At the time of writing none has been confirmed as Earth-directed, however analyses are continuing.

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Overall, at the time of writing, no new CMEs appear to carry any Earth-directed component, however further analyses are being carried out to confirm this. Activity in this group makes it one to monitor, especially as further rotation carries it and any ejecta it may produce nearer the Sun-Earth line.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by ACE at L1, were reflective of a slow solar wind regime. The solar wind speed declined slightly within Background levels from 350 to nearer 325km/s. The solar wind density showed a roughly level tendency within typical single figures ppcc. The IMF was low amplitude and steady throughout, at or below 4nT, while the north-south component ranged between -3 and +2nT. The phi angle was mostly negative (towards the Sun), but with a drift into positive territory around the middle of the UTC day, and signs of an SSBC after 02/2300UTC when the phi angle again became positive.

The net result of the above solar wind measures was provisionally Quiet geomagnetic activity throughout.

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux is currently slightly elevated above Background levels following the M6.8 flare on 29 Jan from Ex-AR3559, but remains well below the S1/Minor Radiation Storm threshold, with a peak of 1.1pfu at 02/1130UTC.

GOES16 high energy (greater than 2MeV) electron flux was at Normal Background to Moderate levels. The associated 24-hour fluence was well below the Active (1e8 integrated pfu) threshold but on a slight rising trend. At 03/0001UTC the 24-hour integrated fluence observation was 5.8e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Overall activity is most likely to be Low, but with an increasing chance of isolated M-class flares.

Solar Wind / Geomagnetic Activity: A CME which left the Sun at 01/0743UTC may deliver a glancing blow either late Saturday 03 February or more likely early Sunday 04 February. In addition there may be also be a fast wind enhancement from CH96/+ during this period, although likely more biased to effects on 04 into 05 February, with solar wind speeds perhaps reaching 450-500 km/s. At this time of year any response to positive polarity coronal holes is expected to be muted.

This period now carries low confidence regarding inbound CMEs due to the prolific activity in AR3571. Although at present no Earth-directed components have been positively identified, analyses are ongoing. Geomagnetic activity is otherwise expected to start and end the four-day period Quiet, with perhaps a peak Chance of G1 should any CIR leading the fast wind from CH96/+ combine with glancing CME effects on Sunday 04 February, with a Slight Chance of similar activity flanking this UTC day.

Energetic Particles / Solar Radiation: High energy proton flux is expected to remain below the S1/Minor Radiation Storm level, with a daily Slight Chance of exceeding the S1 threshold during the period.

The high energy electron flux (greater than 2MeV) is expected to remain below High levels throughout the period, with exceedance of the Active fluence threshold considered unlikely.

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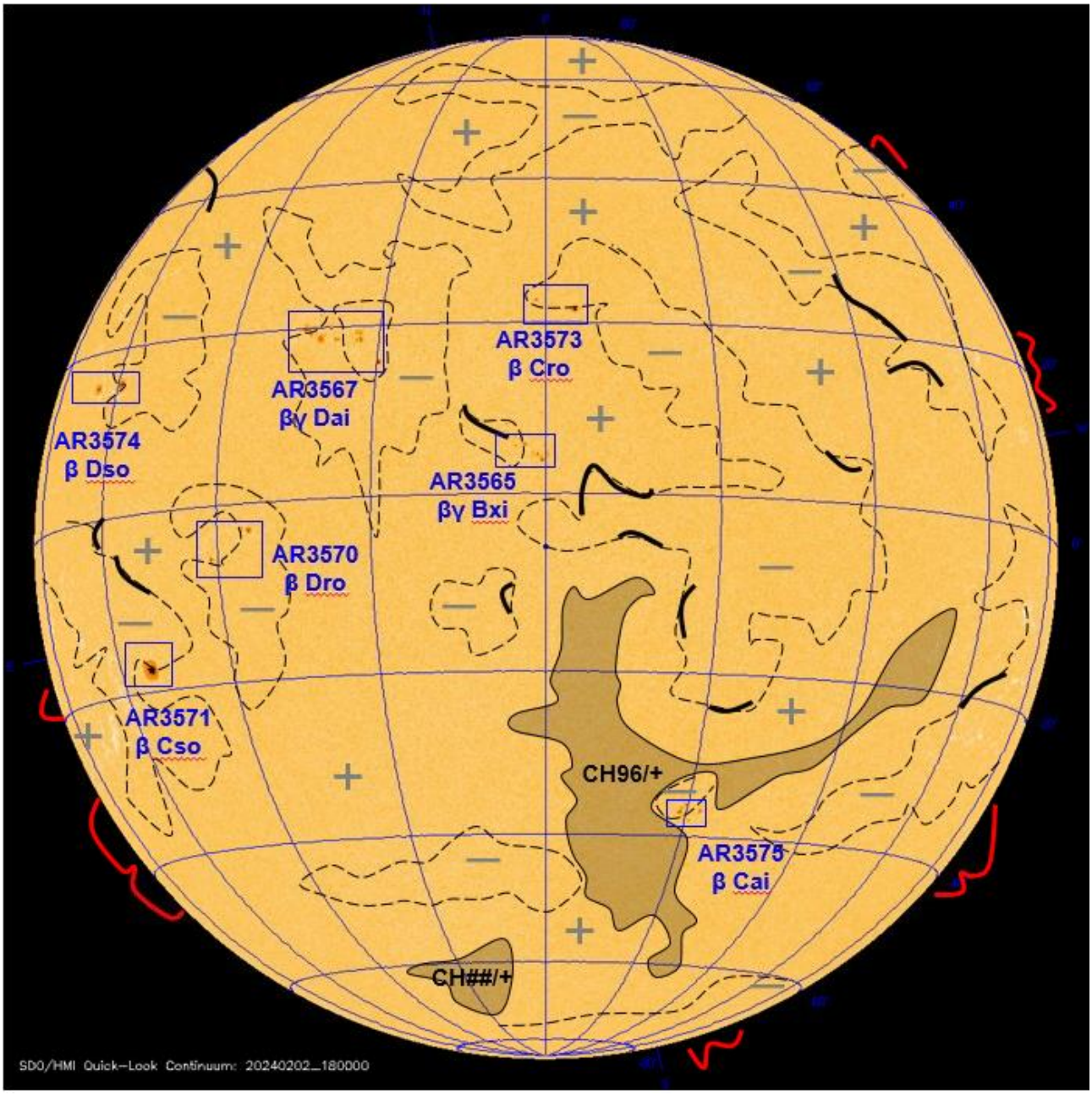
Figure 1. Solar Analysis Valid 02/1800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME which originated from a long-period C3 flare at 01/0743UTC near north-centre disc, may deliver a glancing blow either later on 03 February or more likely early on 04 February. This is the only CME that features in the forecast at present, however it should be noted that confidence in this assertion is lower than typical given the weight of activity from AR3571. Analyses are ongoing.

In addition to the CME contribution to the geomagnetic forecast, there may be also be a fast wind enhancement from CH96/+ in the southern solar hemisphere due during this period. A thin and narrow extension of this CH may become weakly geoeffective from within the current UTC day, however the majority of the HSS arrival is expected to straddle the UTC days of 04 and 05 February with solar wind speeds perhaps reaching 450-500 km/s. However, on the previous rotation, wind speeds barely reached 450 km/s with little geomagnetic response. At this time of year any response to positive polarity coronal holes is expected to be muted.

Geomagnetic activity is expected to start and end the four-day period Quiet, with perhaps a peak Chance of G1 should any CIR leading the fast wind from CH96/+ combine with glancing CME effects on Sunday 04 February, with a Slight Chance of similar activity flanking this UTC day.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	25	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
01/1245	Partial	Plage area	NE	720km/s	04/0600UTC	Glancing blow possible

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Figure 2: Latest MOSWOC Enlil run and ensemble (badge time 02/1800UTC), showing the simulation paused at the 1AU crossing time of the 01/0743UTC CME. Although few ensemble members suggest arrivals as early as the tail end of the current UTC day, the necessarily quicker transit speed and greater potential for impact have led to the 10% G1 risk on 03 February.

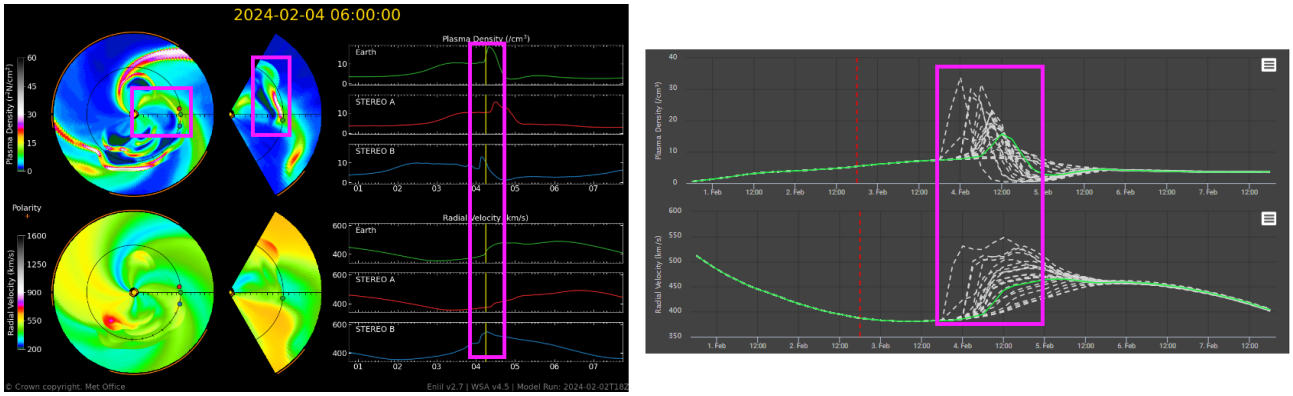
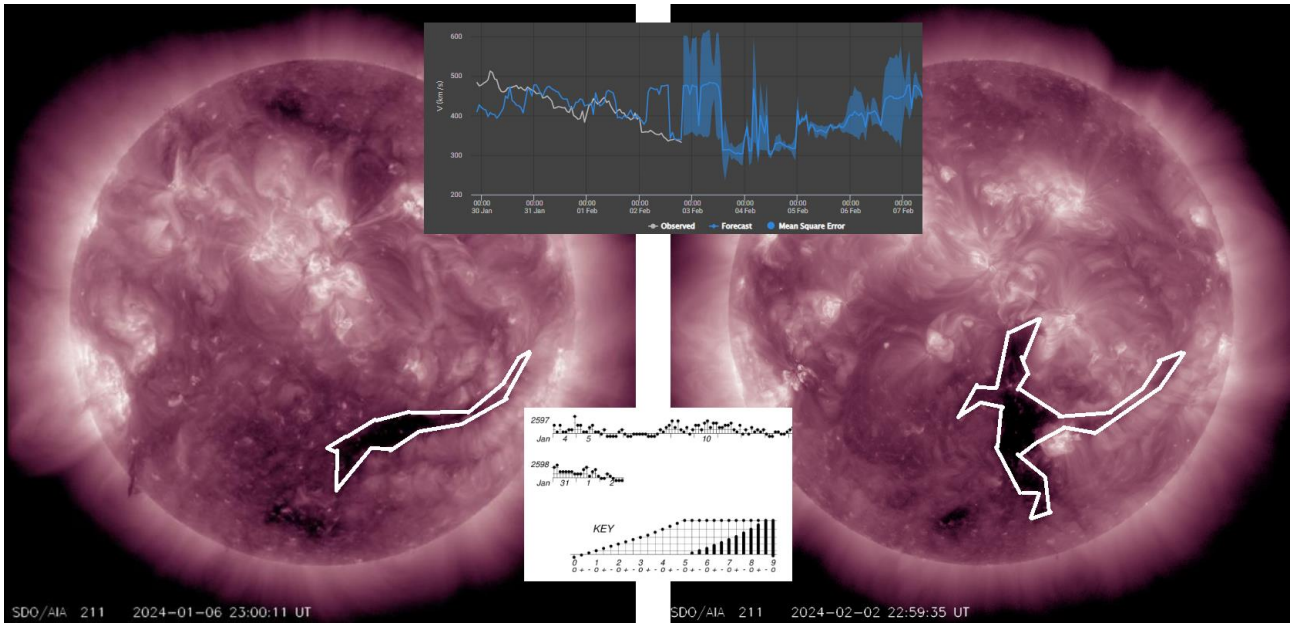


Figure 3: AIA211 imagery from the previous (left) and current rotations, with nested solar wind measures and arising Kp indices. Although solar wind speeds of 450-500km/s are perhaps possible from CH96, arising geomagnetic activity is likely to be muted.



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Radio Blackouts - X-Ray Flares:

There are currently seven sunspot regions on the solar disc, with all of these apparently magnetically bipolar. Despite appearances, the most active of the past 24 hours has been one of the most tenuously bipolar regions, with a very faint trailing spot behind the symmetrical penumbral main leader in AR3571. This region appears to lie in a relatively sensitive environment magnetically, with many of its C and M-class flares in the past 24 hours associated with magnetic arcing forward to CH96 and coronal dimmings on AIA211. AR3671's activity and penchant for producing CMEs make it something to be monitored in the coming days as it approaches the meridian.

Regarding the balance of regions, none of the current cohort are expected to depart the disc in the four days. Meanwhile, on the eastern solar horizon, the returning Carrington location for Ex-3545 is due in the first 24 hours, with some far-side sounding and EUV flux looping evidence suggesting a survival in some form here. This may now have slightly increased the chances of significant X-ray flares from the current UTC day, with this level then held throughout.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	40	40	40	40
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 4: SIDC ROB X-ray flares of C-class and above in the past 24 hours, showing that AR3571 and a possible arriving southeastern limb sunspot region are responsible for the majority of activity, the latter the rationale for the now slightly higher daily Chance of M-class activity in the four days.

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Solar Radiation Storms - (High Energy Protons):

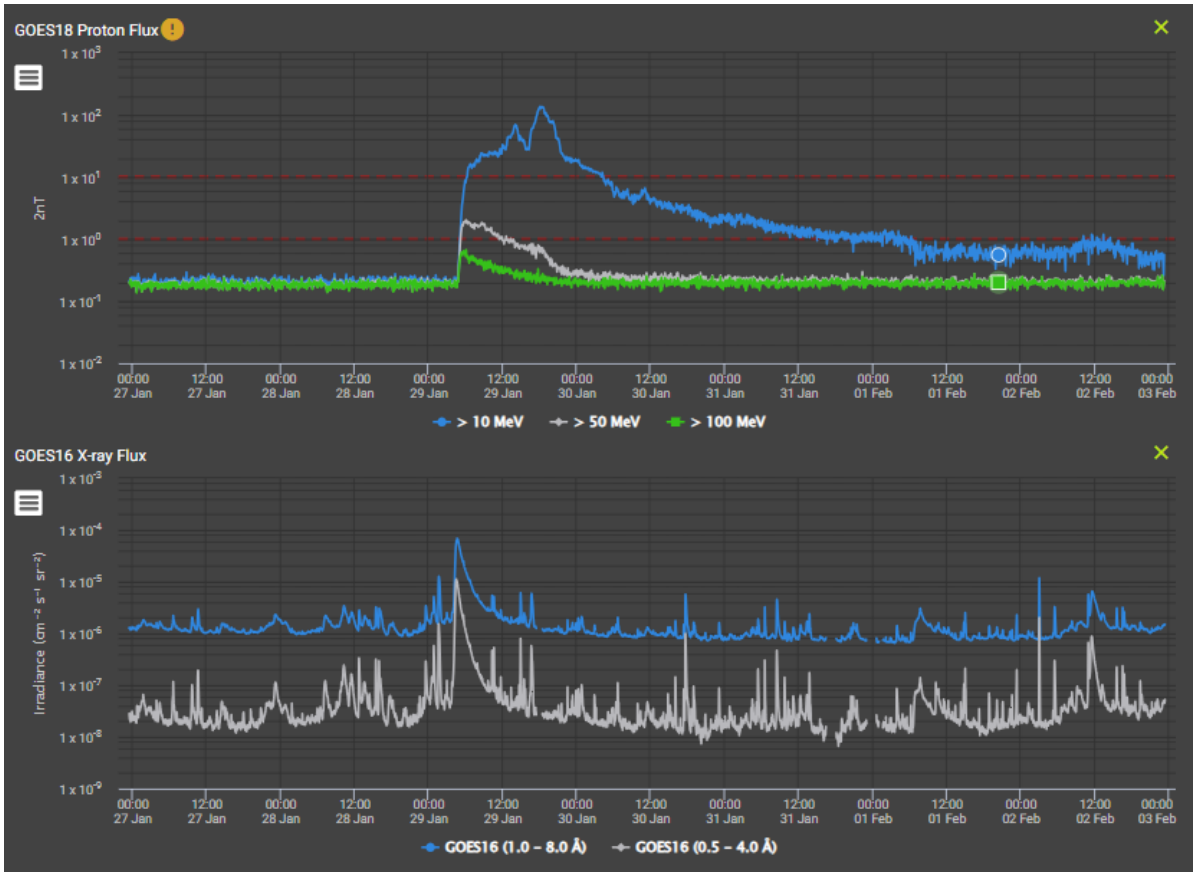
GOES18 high energy (greater than 10MeV) proton flux remains a little above Background levels following the M6.8 flare on 29 Jan from Ex-AR3559, but remains well below the S1/Minor Radiation Storm threshold.

There remains a Slight Chance of reaching S1 levels should any of the regions on the disc produce any larger flares, although this is limited by the vast majority of regions lying in the less well-connected eastern solar hemisphere. AR3559 itself is now well beyond the western limb and no longer contributing significantly to the probability of increased proton flux.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	5	5	5	5
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

Figure 5: Past week in GOES18 high energy proton flux and GOES16 X-ray flares. Note that 10MeV levels remain a little elevated in the wake of the M6.8 flare from 29 January, although the sunspot region responsible is now comfortably on the far side.



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High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) has been mostly at Normal Background levels, with a very slight day-on-day increase in amplitude to finish the UTC working week to give Moderate diurnal peaks. Any CME or HSS effects during this period are most likely to be fairly weak, and lack impetus for a significant increase in electron flux. There is a very low risk of an increase later in the period, should there be a stronger response to the CME or inbound fast wind than expected.

Overall, the electron fluence is expected to remain well below the Active (1e8 integrated flux) threshold, perhaps with a slight rising trend later in the period. MOSWOC REFM's projections are currently underestimating the fluence, but still the overall below-Active trend is thought to be a good guide.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	5	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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